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EXPLORATION METHODS

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INTRODUCTION

Scope and purpose

1. Mineral deposits are rare. They are concentrated forms of wealth. The search for them in the past was often of the nature of a private treasure hunt. The position has radically changed. Mineral exploration programmes are now directed towards developing the potential mineral wealth of the region to the maximum extent possible, to provide the necessary mineral raw material base for industrialisation and to make significant contributions to the national economy through foreign exchange savings/earnings. In relation to this larger objective, scientific systematic, integrated programmes of exploration are of far greater significance than a random search for buried treasure.

2. The purpose of this article is to discuss the various factors which are relevant in drawing up appropriate programmes of mineral exploration and the advantages to be derived through proper integration.

3. The recent developments in mineral exploration in India are briefly described as an illustration of an integrated mineral exploration programme under implementation, which is related to the available opportunities and the specific needs of the country

4. The need and scope for international cooperation in the field of mineral exploration is briefly discussed.

Need for mineral exploration in the under developed countries.

5. The major compelling reasons in favour of mineral exploration programmes in under-developed countries may be listed as under:-

(a) Mineral development is of crucial significance in bringing about rapid increases in gross annual income.

(b) The basic solution to the problem of poverty in under-developed areas is accelerated development in the fields of agriculture, transport, power and heavy industries. All these are large consumers of mineral raw materials.

(c) Low rate of capital formation is a major bottleneck to development in such areas and investments capable of yielding large and rapid returns are very much to be favoured. Well conceived programmes of mineral exploration under favourable conditions meet these requirements.

(d) Minerals, being commodities in international commerce, are important as foreign exchange earners/savers and basis for barters.

(e) Mineral development often acts as a catalyst of general economic development.

(f) Mineral exploration in under developed countries is not merely a national but an international necessity as no country is self sufficient in all minerals. And again rapid depletion of mineral resources is taking place in advanced countries because of intensive exploitation. From the long range point of view, the requirements of mineral raw materials for industries in these countries will have to be met increasingly from new discoveries in under developed countries.

q LIMITING FACTORS IN THE DETERMINATION OF AVAILABLE EXPLORATION OPPORTUNITIES.

6. Well-conceived mineral exploration programmes should be based on scientific anticipations of the available exploration opportunities. There should be adequate recognition of the factors which limit exploration opportunities in a region.

Geological factors

7. The available exploration opportunities in a region are determined in a fundamental way by the geology of the terrain. The relevance of the geological factors to mineral exploration programmes at the planning stage, would consist of demarcating areas of potential interest with respect to various minerals. Apart from broad regional anticipations on the basis of geology of the terrain, specific information with respect to mineral occurrence may be available. Such information would naturally provide a sound basis for estimating exploration opportunities.

Other factors

8. The location of a deposit with respect to its accessability, availability of transport facilities, labour, power and markets, etc., is a determining factor in its minability. Little useful purpose will be served by exploration of mineral deposits in locations, which will render the deposits unminable. What constitutes minable ore is determined by general and local technological conditions. For practical purposes, exploration opportunities are represented only by such deposits as hold out promise of proving minable under the relevant technological conditions.

Exploration opportunities not static

9. Exploration opportunities, however, are not static. New prospects come to light with progress in exploration. Technological developments may bring what was formerly marginal or sub-marginal grade to within the minable grade. General industrial development creates increased demands for mineral raw materials and thus improves the marketability of ore won from a deposit. Exploration programmes, therefore, must be based on a constant review of available exploration opportunities.

A CRITICAL SURVEY OF THE SCOPE AND LIMITATIONS OF DIFFERENT METHODS OF EXPLORATION WITH SPECIAL REFERENCE TO GEOPHYSICAL, GEOCHEMICAL AND PHOTO-GEOLOGICAL METHODS.

10. The ultimate objective of mineral exploration is the exploitation of the mineral wealth. This objective cannot be realised at one bound. Mineral deposits are rare and for the purpose of exploitation, very detailed information, obtainable only through intensive exploratory and proving operations, involving considerable expenditure of time and money, is necessary. Such intensive operations can

only be justified in selected promising prospects. The problem in mineral exploration, therefore, is essentially one of narrowing down the field of operations through successive stages in the exploration programme, and finally carrying out intensive exploration and proving operations in individual prospects for the purpose of converting them into working mines.

11. The whole gamut of activities relating to the acquisition of knowledge essential for exploitation of mineral wealth constitutes mineral exploration. These activities can be conveniently divided into a number of stages. These are -

(i) Regional reconnaissance surveys.
(ii) Detailed investigations of mineralised districts.
(iii) Preliminary appraisal of new prospects.
(iv) Detailed exploration and proving operations in selected prospects.

12. The different methods in exploration have all a common objective, namely, the discovery of minable ore bodies or mineral deposits and obtaining all the data essential for planning their exploitation although their scope and limitations are different at the different stages. The exploration methods can be conveniently classified into the following groups:

(a) Field geological methods.
(b) Photo geological methods.
(c) Geophysical methods
(d) Geochemical methods.
(e) Drilling and exploratory mining.
(f) Laboratory investigations.

13. The scope and limitations of the different methods can be most significantly discussed in relation to different stages in exploration.

14. The main objective at this stage is to obtain, as quickly as possible, a broad picture of the regional geology, so that the available areas, worthy of more detailed investigation, can be demarcated. The location of individual prospects has to be regarded only as an incidental opportunity that may be taken advantage of. The extent to which this work is essential, before more advanced stages of exploration can be initiated, will depend on the information already available. In completely virgin areas, for which even topographical maps are not available, aerial photography and aerial photogeology are ideally suited. Ground geological work cannot be totally eliminated, since the effectiveness of photo interpretation will depend, to a great extent, on the control data available from ground geological investigations. Generally speaking, even geophysical methods employing airborne instruments will not be applicable at this stage. Geochemical investigations could be undertaken as an adjunct to ground geological investigations. The question of employing drilling and mining at this stage does not arise. The scope and limitations of photo-geological methods vis-a-vis ground geological methods merit the most serious consideration in this connection.

15. The major advantages of photo-geology may be briefly stated as follows:

(a) The slow and more expensive ground geological investigations may be confined to critical areas.

(b) The selection of critical areas in advance is likely to lead to successful results in mineral exploration, earlier than can be otherwise expected.

(c) By limiting the areas for ground examination, the services of really competent and experienced geologists could be more effectively utilised.

(d) The delineation of rock outcrops would result in a great reduction in the time and energy spent in mapping, by limiting ground examination, only to areas where such examination is feasible.

(e) Supervision of ground geological work is possible only by going over the ground. Whereas, photo-geological interpretation can be easily checked by a more experienced person by re-examination of the photographs.

(f) The regional geological picture would require constant review, in the light of additional data collected in the course of detailed investigations. Such re-views would be easy to carry out through photo-geological interpretation, whereas in the absence of photographs actual ground work will be necessary.

(g) The photograph is an objective and detailed reproduction of all features which can find an expression in it. There is no personal bias in elimination or selection of details. In actual ground mapping, at the reconnaissance stage, a feature not considered significant, would not receive attention. Such a feature may turn out to be extremely important from the point of view of search for ore. The only way of working out the regional implications of the significant feature, in the absence of photographs, would be going over the ground once again. On the photographs, repetitions of the same feature can be readily interpreted, with little expenditure of time and money.

(h) Even a thin cover would prevent ground geological examination, but this would not stand in the way of photo-geological interpretation.

(i) Where the ground is covered by a thick canopy of trees, it may be almost impossible to do any ground geological work. Photogeology, on the other hand, which relies essentially on morphological expression on geological features, would be able to give significant pointers for mineral search, even under such conditions.

16. Photo-geological methods have a number of limitations. Photo interpretation is based essentially on the study of morphology, tone, texture and linears which show up on the photographs. The geology of a region to the extent it is reflected in recognisable features on the photographs can be interpreted through photo-geological studies. The contacts between different formations and rock types can be traced, faults, fractures, joint patterns, etc. can be identified and areas where rock exposures may be expected, can be demarcated. The approximate depth of soil cover can be estimated. Vital information, such as, the actual nature of the rock type, their mineral composition, the fossil contents of beds, etc., cannot be obtained.

17. To sum up, photo-geological methods without adequate ground control, may yield results of little practical significance; but with adequate ground control, they can greatly accelerate the progress of mineral exploration programmes.

18. Geochemical investigations are ground methods and can be conveniently carried out along with the ground geological work. Geochemical sampling results, at this stage, may help in the location of likely mineralised districts, as well as the elements which may be expected to be found in the district. Apart from this possibility, it is being increasingly recognised that geochemical data are of fundamental significance in the understanding of the geology of an area, in relation to economic mineralisation. It is best to build up a geochemical map right from the early stages.

Detailed investigation of mineralised districts

19. On the basis of the regional geological picture, the likely mineralised districts would have been already delineated. In the next stage, the detailed

investigation of the mineralised districts would be commenced. The ground geological methods would become essential at this stage. The mapping will be on a larger scale (1-10,000) and would be specially oriented in relation to the types of mineralisation which are being looked for. Detailed investigations for oil, coal, iron ore, base metals, precious metals, etc. would all call for specialised procedures at this stage. The mapping may still be done on large scale aerial photographs, the geology being subsequently transferred to toposheets by means of a sketchmaster. Photo-geological interpretation would play a small role directly. It may, however, still play an important role indirectly. Any important feature recognised on the ground, which finds expression on the photographs, may be interpreted by photo-geology over the entire district, so that critical attention may be given to such areas. Geophysical and geochemical methods will begin to play an increasingly important role. The scope and limitations of the geophysical and geochemical methods may be briefly considered in this connection.

20. Geophysical methods are indirect methods, which attempt the detection of geophysical anomalies. The chief methods are seismic (refraction and reflection), gravity, magnetic, electro-magnetic, electrical and radio-active. The methods can be used singly or in combination. The seismic and gravity methods have great depth penetration and are valuable where structure is an important localising factor in mineralisation, as in the case of oil. They are relatively more expensive and are ground methods. The magnetic, electro-magnetic and radio-active methods are comparatively cheaper and are also capable of being employed in aerial surveys.

21. The presence of a geophysical anomaly by itself does not indicate the presence of a mineral deposit. In the search for iron ore, for instance, a strong anomaly may be obtained for a magnetite bearing quartzite, while no anomaly may be found for a large hematite ore body. Where a problem in mineral exploration is geologically defined and indicated as capable of geophysical exploration, the use of geophysical methods can give extremely valuable results. In the case of concealed ore bodies, where geophysical investigations are applicable, they should always be tried before resorting to the more expensive methods of drilling and exploratory mining. Areas suggested by photo-geological interpretation can be geophysically surveyed prior to detailed investigation.

22. Geochemical investigations have a fundamental significance in the understanding of the geology of an area and are also proving increasingly useful in the exploration of mineral deposits. They have found wide application in the exploration for oil as well as for a variety of metals. The major developments are related to improvements in analytical techniques. The improvements in analytical methods have been in two directions - (i) Increase in accuracy and (ii) Increase in the rate of routine analyses.

23. The geochemical cycles for a number of elements are being worked out and the results show a very significant relationship between the geochemical cycle of elements and deep-seated geological processes, such as tectonism, metamorphism, igneous activity etc. as well as near surface geological processes such as, weathering, erosion, sedimentation etc.

24. Geochemical methods are directed towards the recognition of dispersion halos of elements, but the significance of the halos in relation to the prospects of finding ore can be determined only by a critical study of the geochemical data in relation to the geological data. The cumulative weight of geochemical data over an entire region is likely to prove of greater practical significance than random localised investigations. The practice in the Soviet Union of preparing geochemical maps, along with geological maps is likely to obtain wider currency.

25. An attempt should be made to apply the principle of converging evidence. Geological, geophysical and geochemical investigations should be carried out and in the light of the results obtained, more detailed exploration should be undertaken.

Preliminary appraisal of prospects.

26. Preliminary appraisals will have to be carried out in selected prospects to determine (a) whether detailed proving operations are justified in the deposit; and (b) if so, the character and extent of the exploratory work considered necessary.

27. In arriving at a conclusion with respect to (a), the considerations to be kept in view are the following:-

(i) The prospects of reaching a positive conclusion.
(ii) The minimum and maximum prospects which can be foreseen on the available evidence.
(iii) The relative merits of the prospects as compared to other known prospects.
(iv) Is the localisation of ore in the deposit sufficiently well-understood to render detailed exploration immediately practicable.

28. In the preliminary appraisal, the principle of calculated risk as well as the principle of the weakest link must be kept in view. While geological considerations alone would have received attention at the early stages, from the initial appraisal onwards, mining considerations must be given equal weight.

29. All the data collected through detailed geological investigations, geophysical and geochemical investigations have to be critically examined before reaching conclusions on the points listed above. Once it is decided to select a prospect for detailed proving operations, the nature and extent of the exploratory work to be carried out will have to be determined. In certain cases, especially in sedimentary deposits the entire programme may be visualised in outline right from the start. In the case of lode deposits, this would not often be possible. An initial programme has to be drawn up on the results of which the nature and extent of further work to be carried out, will be decided.

Detailed exploration and proving operations in selected prospects.

30. Detailed geological investigations, drilling and exploratory mining constitute the chief methods in this stage. These operations are of an intensive character directed towards the obtaining of conclusive evidence essential for taking the decisions with respect to the major investment involved in exploitation as well as the collecting of the relevant data essential for proper planning of the exploitation of the deposit. Geological investigations are necessary for the purpose of guiding drilling and exploratory mining operations and for interpreting the data resulting from them. Detailed surface investigations including preparation of large scale contour geological plans, shallow pitting and trenching have the great advantage of being both rapid and cheap and maximum advantage should be taken of data obtainable in this manner. Under ideal conditions, such investigations can provide comprehensive, accurate quantitative data, which can form the main basis of appraisal. This is often the case with deposits of coal, iron ore, limestone, manganese, gypsum etc., where quarriable reserves are to be assessed.

31. For a variety of reasons such as, paucity of exposures, existence of minable ore at depths not reachable by pits and trenches etc., it is often necessary to supplement the near surface data with bore hole evidence, and data from exploratory mining.

32. The major problems in the integration of methods at this stage would consist of determining the relative extent to which different methods have to be employed. In some cases, estimates of reserves and grade of ore may be made on the basis of surface evidence coupled with bore hole data. In the case of lode deposits exploratory mining is often an inescapable part of the proving operations. A decision in this regard can be taken only after the localisation of the ore is properly understood. Since exploratory mining is time consuming, an attempt has to be made to start it as early as possible. There is, therefore, necessity to plan the surface examination and drilling operations in such a way as to enable a quick choice to be made of the ground where exploratory mining has to be carried out. In planning exploratory mining, the possibility of making it a part of development for exploitation should be kept in mind.

33. Geo-physical logging of bore holes can be carried out for purposes of correlation as well as for guiding the exploratory operations. Geo-Chemical determination of core and sludge samples can be carried out for investigation of the dispersion halos in depth.

NEED FOR SCIENTIFIC, PLANNED AND INTEGRATED PROGRAMMES OF EXPLORATION

Role of science vis-a-vis risks and opportunities in exploration

34. The risks involved as well as the opportunities available in mineral exploration are great. Instances are not rare where over a thousand million rupees have been spent in exploration for oil without resulting in the discovery of any commercially exploitable pool of oil. There have been many costly failures in the search for deposits of precious and base metals in different parts of the world. Mineral exploration, where successful, however results in enormous returns in relation to the investment involved. The Kuwait oil field yields in terms of royalties alone £55 million annually. The Butte, Montana, copper deposit alone has yielded over 2.5 billion dollars worth of metal. The Kolar gold-field has produced around 2000 million of rupees worth of gold.

35. Mineral exploration in the past had been, for the most part, a random uncoordinated effort by individuals with little or no scientific background. Scientific exploration is now a necessity for a variety of reasons. Mineral development is essential for industrial development and has to keep pace with it. It can not any longer depend on the slow and uncertain results of random search. The great variety of mineral raw materials required by industry do not all lend themselves to the simple and primitive methods of search. Mechanised mining of low grade ore involves large capital investment and such investment cannot be made unless sufficient reserves, capable of amortizing the capital, are proved in advance and all the data essential for the planning and execution of the project are collected. Rich, readily recognisable prospects are relatively few, and random methods of search are capable of developing only a small part of the overall mineral potentiality of a region.

36. The Broad strategy of mineral exploration consists of narrowing down the field of operation through successive stages in the exploration programme and finally concentrating detailed proving activities in selected prospects and thereby convert them into working mines. Valuable opportunities should not be missed and unwarranted risks should not be taken. A long, dark and difficult path has to be tread before the mineral potentiality of a region is converted into mineral production. To make the journey swift and secure, the light of science is essential.

The essentials of an integrated programme of exploration

37. Programmes of exploration have to be properly integrated to ensure the maximum results in minimum time at minimum cost. The integration has to take account of the specific needs for mineral exploration of the region under consideration, the available mineral exploration opportunities in the region, and the scope

and limitations of different methods of exploration at different stages of exploration.

38. Apart from integrating the different methods of exploration at the different stages, it is essential to look upon the different stages in exploration as parts of the broad strategy of mineral exploration of the region. In the course of detailed investigations of mineralised districts, the relative importance of various favourable features would be more accurately determined and certain new features, whose significance was not appreciated in the course of regional reconnaissance survey, might turn out to be extremely useful in the search for ore. The regional survey maps must be reviewed in the light of the new evidence and fresh demarcations of mineralised districts carried out. Preliminary appraisals of prospects might indicate features of interest in the recognition of prospects, which might have escaped notice earlier. The mineralised districts may require to be gone over in the light of fresh data.

39. Every mineralised district has distinct features and patterns of mineralisation. General geological theory can only indicate what can happen; but what indeed happens in a particular district has to be ascertained through detailed critical studies of data available from the different stages in exploration as well as from working mines. Detailed exploratory and proving operations can be undertaken only where there are prospects of finding minable ore. Exploitation is undertaken for the purpose of winning ore. Yet data obtainable as a result of these two activities, are of critical research significance in the science of ore search and appraisal with special reference to specific mineralised districts.

RECENT DEVELOPMENTS IN MINERAL EXPLORATION IN INDIA.

40. Revolutionary changes have taken place in the purpose, scope, tempo and nature of mineral exploration in India subsequent to 1947 when the country became independent. In many directions, in this field, what has been accomplished in the short span of 15 years subsequent to that date, exceeds in volume and variety what was achieved in the previous 100 years.

41. In the field of mineral exploration the role of the Geological Survey of India relates to the preparation of basic geological maps and the regional investigations of mineralised districts. In this connection, in addition to conventional geological methods, photogeological, geo-chemical and geo-physical methods are employed. Ground mapping on aerial photographs in a number of mineralised districts, such as the Zawar lead-zinc district, the Khetri and Dariba Copper districts and the Singhbhum copper belt have been carried out. The geo-physical surveys, employing seismic, gravimetric, magnetic and electrical methods have been carried out to locate favourable structures for oil as well as in connection with exploration of concealed deposits in a variety of minerals including copper lead, graphite, pyrites, diamond, etc. The geo-chemical investigations have been comparatively limited in scope and have not been directed towards the preparation of geo-chemical maps of the region. So far, they have been of the nature of testing out the different geo-chemical methods for the purpose of calibration in known mineralised areas, and for locating concealed extensions of known mineralised ground.

42. The Indian Bureau of Mines came into existence only in 1948 and its total strength consisted of a Director and two officers and the functions were limited to acting as an advisory body to the Government. To-day it has a total strength of around 150 officers and the scope of activities embrace a variety of functions including the introduction of scientific methods of prospecting, exploration, mining and utilisation of minerals through the systematic and regular inspection of mines, carrying out detailed exploratory and proving operations to convert prospects into workings mines; conducting research investigations in the field of mineral beneficiation and mineral technology; and the collection, collation and interpretation of statistical data relating to all aspects of India's mineral industry, such as

production, consumption, marketing, import, export, reserves and grade, utilisation etc.

43. A few of the important results of detailed exploratory and proving operations carried out by the Indian Bureau of Mines: are given below:-

Mineral	Reserves proved
a) Coal	1577.8 million tonnes
b) Iron-ore	491.1 million tonnes
c) Limestone and	88.6 million tonnes
dolomite	10.2 million tonnes
d) Copper Ore	100 million tonnes average grade 1% Cu
e) Copper-lead-zinc ..	0.36 million tonnes, Total metal content 6.24%
f) Pyrites	76.2 million tonnes, Sulphur content 40%
	Indicated reserve - 313.9 Million Tonnes.
g) Magnesite	12.19 million tonnes, containing about 41 to 46% magnesia.

44. The basic approach of the department has been not to limit the objective of proving operations to the narrow purpose of finding ore in individual prospects but to regard the entire exploration and proving operations as a major programme of scientific investigation involving the application of the test of predictability. The result is that a constantly growing body of scientific knowledge of great practical significance to mineral exploration in different mineralised districts of the country is being created and full advantage is being taken of the cumulative value of this knowledge in the execution of fresh items in the programmes of mineral exploration.

45. While the latest techniques in mineral exploration such as, geochemical prospecting, geo-physical prospecting and aerial survey, etc., are extremely valuable aids in mineral exploration, India has a peculiar national asset, namely, a long tradition of civilised life, which is reflected in the shape of numerous old workings for gold, copper, lead, zinc, silver, etc. in different parts of the country. The old workings, provide a wealth of data, which have proved of immense help in the search for ore by the Indian Bureau of Mines.

46. Recently a scheme of rewards to private parties bringing to the notice of the government mineral finds of economic importance has been instituted which will ensure that even layment play their role in the extensive search for mineral prospects.

47. A separate Oil and Natural Gas Commission has been set up to carry out oil exploration on a major scale in the country. In addition to the conventional methods, latest methods in exploration for oil are employed by the Commission including aeromagnetic surveys, geo-physical surveys and photo-geological surveys. Notable success has already been achieved in the Cambay and other areas in Gujarat.

48. The department of Atomic Energy is carrying out extensive radio-metric surveys, both on the ground and by air, in their search for deposits of radio-active minerals.

49. A significant amount of mineral exploration is being done by the private sector as well. Introduction of scientific methods of prospecting and exploration in the private sector is the responsibility of the MC & CM Division of the Indian Bureau of Mines. Tata Iron & Steel Co. Ltd have their own prospecting organisation.

50. In relation to the country's needs, as well as potential mineral wealth, a vast increase in mineral exploration activity in all stages, including regional investigations, detailed investigations, of mineralised districts and detailed exploratory and proving operations in selected prospects, is justified. India is an example of an under-developed country, where planned, scientific and integrated mineral exploration programmes are being implemented, employing both the conventional methods as well as the new ones, such as, photo-geological, geochemical and geo-physical methods.

THE SCOPE AND NEED FOR INTERNATIONAL CO-OPERATION IN THE FIELD OF MINERAL EXPLORATION

51. There is a great scope as well as a need for international co-operation in the field of mineral exploration. The mineral requirements of the world will have to be increasingly met from under-developed countries, as deposits in the more advanced countries get exhausted by intensive exploitation. In the exploration of the under-developed areas, the technical and scientific resources in the possession of the advanced countries would require to be employed. As exploration programmes begin to meet with success in under-developed countries, a position of imbalance with respect to raw material resources and plant capacity is likely to ensue. In other words, under-developed countries may have an excess of mineral raw material resources, while the advanced countries will have an excess of plant capacity. Thus a world economy can be built by effecting the necessary adjustments through co-operation and goodwill. From the long range point of view, the advanced countries have an important stake in accelerating the pace of mineral exploration in under-developed countries. The various directions in which international co-operation is desirable as well as the scope for such co-operation, are briefly indicated below:-

52. Exchange of information:- The results of the considerable amount of work mainly being carried out in the Soviet Union are not easily accessible to those who do not know Russians. It would be a very great help if an annotated bibliography of all scientific work carried out in the Soviet Union in the field of mineral exploration is made available in English and translations of the original papers can be obtained on specific request. If a directory of all specialists holding responsible positions in mineral exploration programmes in different countries of the world is prepared, along with brief information indicating their areas of interest, it may greatly facilitate direct correspondence and discussion among specialists working on the same problems in different parts of the world.

53. Exchange and deputation of personnel:- A varied field experience is an extremely valuable asset to any one engaged in mineral exploration. Exchange and deputation of personnel is a very effective means of providing an opportunity for the acquisition of such varied experience.

54. Exchange of samples:- It is not possible for any individual to see all the mineral deposits of the world, even with respect to one mineral. It is, however practicable through international co-operation to arrange for every country having a complete set of minerals from all the important mineralised districts of the world, along with a brief note on the geology of the deposits. Such an exchange of samples would be of great help in exploration.

55. Facilities for training of personnel:- Training facilities can be extended in two ways. Specialists in different branches of exploration can be sent to the under-developed countries for training personnel in those countries. Opportunities for training in the advanced countries can be provided to selected persons from the under-developed countries. Help in both the directions is presently being extended, but the scope of such help requires to be further increased.

56. Supply of equipment and instruments to under-developed countries:-Help is being received by the under-developed countries in the matter of supply of equipment and instruments, but it is still far from adequate. Assistance in the manufacture of equipment and instruments in the under-developed countries would represent a more fundamental and satisfactory solution for this problem, and should be extended in increasing measure wherever opportunities exist.

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